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# SOME RESULTS OF THE ANALYSIS OF THE BELGRADE ZENITH-TELESCOPE OBSERVATIONS

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**Abstract.** Original Belgrade zenith-telescope observations in the period 1949-1985 have undergone a new reduction in the FK5 reference frame. The mean error of the instantaneous latitude from one Talcott's pair is less than before. Our re-reduction was a part of the Hipparcos programe. An analysis and some results of the re-processing are presented here.

## 1. INTRODUCTION

The re-reduction of the Belgrade ZT (visual zenith-telescope Askania-Bamberg, 110/1287 mm) observations made in the period 1949–1985 was carried out in accordance with the Hipparcos programe (ESA, 1989) and decision of WG ERHRF (the Working Group on Earth Rotation in the HIPPARCOS reference frame).

The procedure of the new reduction of the New Belgrade Latitude Programme – NP (Ševarlić and Teleki, 1960) for the period 1960–1985 and of the Old Belgrade Latitude Programme – OP (Djurković,Ševarlić, Brkić, 1951) for the period 1949–1960 has been presented earlier (Damljanović, 1994; Damljanović, 1995). Use has thereby been made of the PPM Star Catalogue (Röser & Bastian, 1991), the FK5 reference frame, 1976 IAU astronomical constants, 1980 IAU nutation model, the dynamical reference system (defined by JPL DE200/LE200 ), the epoch J2000.0. All the changes in our re-reduction are in accordance with MERIT standards (Melbourne *et al.*, 1983). The refraction (Abalakin, 1985), the correction for the curvature of the parallel, the wind effect, the deviation of the vertical, the E–W effect, the effect of the statistical parallaxes for the stars without trigonometric parallaxes, the effect of the level bubble lenght variation, the temperature terms of the levels, the systematic errors of declinations and proper motions, and the personal equation were applied. The latitudes are in line with 1979 BIH system.

After our re-reduction the mean error (of the instantaneous latitude from one Talcott's pair) came out less than before; $\pm 0.''199$ for OP and $\pm 0.''148$ for NP, and the Belgrade latitudes observations are in better accordance with 1979 BIH system and the observational material has been homogenised as much as possible. We analysed that material and found some interesting periods.

In the lenght of day fluctuations there exist the quasibiennial (QBO) and 4–6 year oscillations (Dickey *et al.*, 1994). These oscillations are detected in the polar motion also (Abarca *et al.*, 1994). The QBO phenomenon is discussed in Djurović

and Pâquet (1990, 1993). The results suggest the mentioned 4–6 year oscillation as been due to the 5.5 (FYO) oscillation whose the excitation originate in the solar activity. This and other periods have been found earlier in the solar–activity study by using Wolf's number (W), the geomagnetic field (Aa) and the differences UT2 - UTC (UT) (Djurović, 1981; Djurović, 1985). For UT, W, Aa exist the oscillations with next periods: 11.0, 10.8, 7.4, 6.6, 3.5, 3.3 year. For W, Aa : 5.4, 5.3, 2.0, 1.9 year periods. For UT : 2.3 year periods. Jovanović (1993) analysed the variation of the Belgrade mean latitude (old reduction) over the period 1949–1985 and the oscillations obtained in the calculations are with periods 7.8, 3.5, 2.3 year (OP) and 10.7, 6.7, 4.1, 3.1, 2.2, 1.1 year (NP). After the finish of our re–reduction we made the analysis of the Belgrade material and found a few interesting oscillations. The preliminary results are in accordance with other above mentioned.

## 2. COMPUTATION METHODS

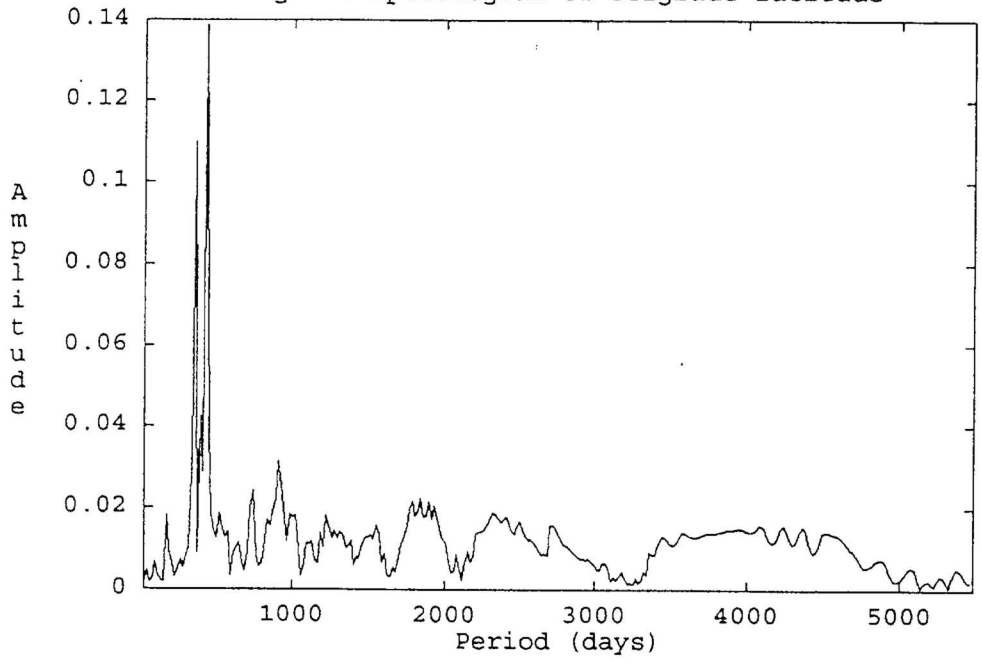
The methods of analysis are: the Vondrak (V) method (Vondrak, 1969) for the smoothing and filtering of data, and the Direct Fourier Transform (DFT) for spectral analysis.

## 3. RESULTS

From our raw data analysed by the DFT method results are obtained as illustrated in Figure 1. After that, for each period of interest we filtered the series by a double filtering using the V method with the selected parameters $\varepsilon_1$ and $\varepsilon_2$. Using the formula of Kun–Yi and Zhou (1981) we determined the values for $\varepsilon_1$ and $\varepsilon_2$. In the first step to detect interesting oscillation the data are smoothed by the V method with a smoothing parameter $\varepsilon_1 = 3.5 * 10^{-15}$ and the secular and long–period components of the signal are eliminated (the part of the signal–the residuals which is kept for further analysis is on the left of the amplitude gain factor curve $1 - G_1 = 0.99$). The residuals of the first smoothing (with $\varepsilon_1$) have got the known seasonal terms. In the second step the seasonal oscillations are removed from the residuals by the V smoothing with $\varepsilon_2 = 3.5 * 10^{-11}$ (the amplitude gain factor is $G_2 = 0.01$). The amplitude of pseudo–oscillations resulting from the V double filtering (in our case) is smaller by a factor about 0.01. The results are obtained as illustrated in Figure 2 : the period is 2.05 year, the amplitude is $0.''017$. With $\varepsilon_1 = 1.1 * 10^{-15}$ and $\varepsilon_2 = 1.0 * 10^{-11}$ the results are obtained as illustrated in Figure 3 : the period is 2.50 year, the amplitude is $0.''024$. With $\varepsilon_1 = 1.8 * 10^{-16}$ and $\varepsilon_2 = 1.8 * 10^{-12}$ the results are obtained as illustrated in Figure 4 : the period is 3.35 year, the amplitude is $0.''014$. With $\varepsilon_1 = 5.1 * 10^{-17}$ and $\varepsilon_2 = 5.0 * 10^{-13}$ the results are obtained as illustrated in Figure 5 : the period is 4.15 year, the amplitude is $0.''012$. With $\varepsilon_1 = 1.6 * 10^{-17}$ and $\varepsilon_2 = 1.5 * 10^{-13}$ the results are obtained as illustrated in Figure 6 : the period is 5.05 year, the amplitude is $0.''018$. With $\varepsilon_1 = 3.6 * 10^{-18}$ and $\varepsilon_2 = 3.6 * 10^{-14}$ the results are obtained as illustrated in Figure 7 : the period is 6.45 year, the amplitude is $0.''014$. With $\varepsilon_1 = 1.6 * 10^{-18}$ and $\varepsilon_2 = 1.6 * 10^{-14}$ the results are obtained as illustrated in Figure 8 : the period is 7.40 year, the amplitude is $0.''009$. And with $\varepsilon_1 = 2.2 * 10^{-19}$ and $\varepsilon_2 = 2.1 * 10^{-15}$ the results are obtained as illustrated in Figure 9 : the period is 10.30 year, the amplitude

is $0.''010$. The amplitude gain factor $1-G_1$ is 0.99 and $G_2 = 0.01$, always. We marked the periods of interesting with asterisk (on the figures).

Fig. 1. Spectrogram of Belgrade latitude



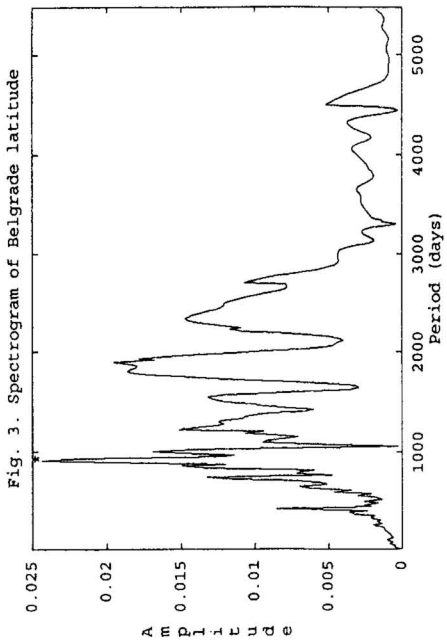


Fig. 3. Spectrogram of Belgrade latitude
Amplitude
Period (days)
0.025
0.02
0.015
0.01
0.005
0
1000
2000
3000
4000
5000

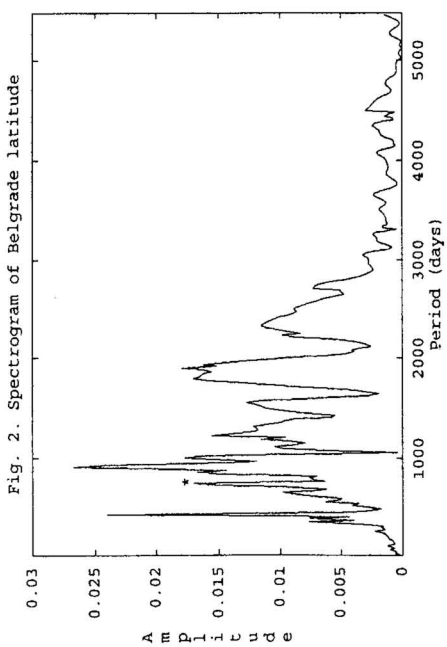


Fig. 2. Spectrogram of Belgrade latitude
Amplitude
Period (days)
0.03
0.025
0.02
0.015
0.01
0.005
0
1000
2000
3000
4000
5000

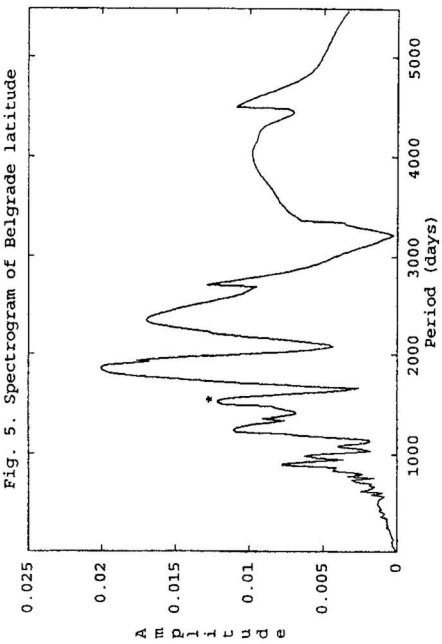


Fig. 5. Spectrogram of Belgrade latitude
Amplitude
Period (days)
0.025
0.02
0.015
0.01
0.005
0
1000
2000
3000
4000
5000

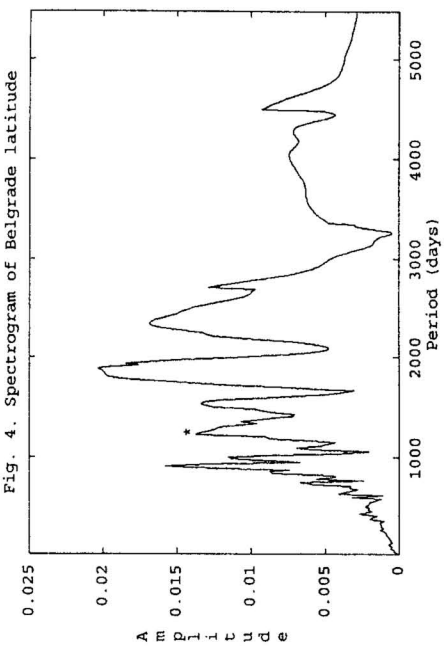


Fig. 4. Spectrogram of Belgrade latitude
Amplitude
Period (days)
0.025
0.02
0.015
0.01
0.005
0
1000
2000
3000
4000
5000

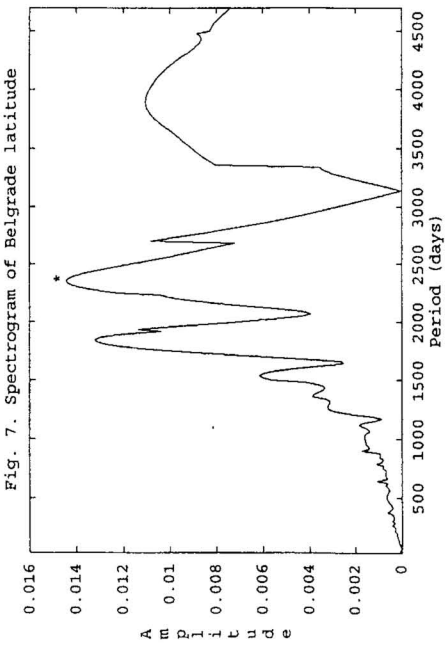


Fig. 7. Spectrogram of Belgrade latitude
Amplitude
Period (days)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
500 1000 1500 2000 2500 3000 3500 4000 4500

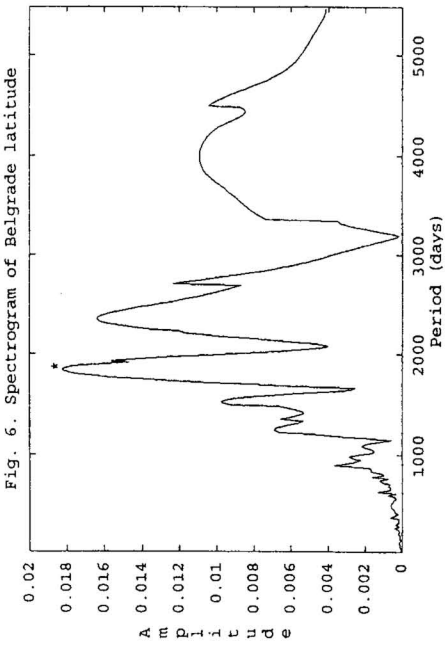


Fig. 6. Spectrogram of Belgrade latitude
Amplitude
Period (days)
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
1000 2000 3000 4000 5000

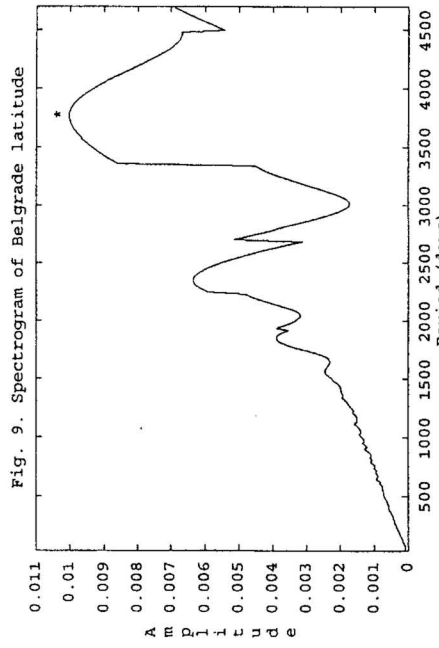


Fig. 9. Spectrogram of Belgrade latitude
Amplitude
Period (days)
0.011
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
500 1000 1500 2000 2500 3000 3500 4000 4500

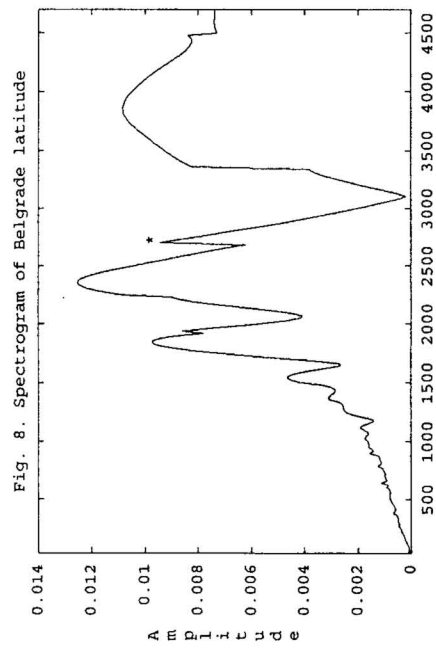


Fig. 8. Spectrogram of Belgrade latitude
Amplitude
Period (days)
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
500 1000 1500 2000 2500 3000 3500 4000 4500

## 4. CONCLUSION

Our results are in accordance with the results of other authors. The Belgrade 36 years observations made with classical ZT instrument after re-reduction have supplied data suitable for the analysis presented here.

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